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McMahan et al.

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(54) **TRANSITION DUCT ASSEMBLY WITH MODIFIED TRAILING EDGE IN TURBINE SYSTEM**

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F01D 5/14 (2006.01)

(52) **U.S. Cl.**
CPC ***F01D 9/023*** (2013.01); ***F01D 5/141*** (2013.01); *F05D 2240/122* (2013.01); *F05D 2250/182* (2013.01); *F05D 2250/183* (2013.01); *F05D 2250/71* (2013.01)

(58) **Field of Classification Search**
CPC F01D 9/023; F01D 5/141
See application file for complete search history.

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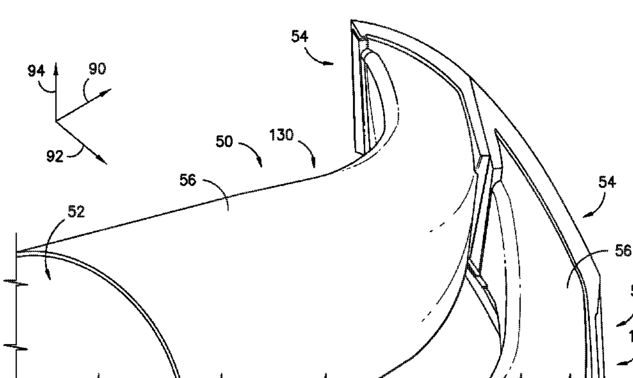
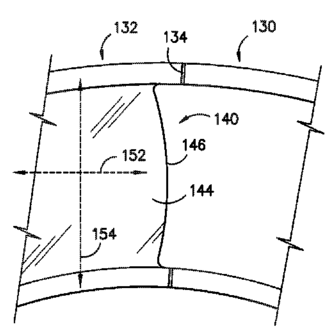
(57) **ABSTRACT**

Transition duct assemblies for turbine systems and turbomachines are provided. In one embodiment, a transition duct assembly includes a plurality of transition ducts disposed in a generally annular array and comprising a first transition duct and a second transition duct. Each of the plurality of transition ducts includes an inlet, an outlet, and a passage extending between the inlet and the outlet and defining a longitudinal axis, a radial axis, and a tangential axis. The outlet of each transition duct is offset from the inlet along the longitudinal axis and the tangential axis. The transition duct assembly further includes an aerodynamic structure defined by the passages of the first transition duct and the second transition duct. The aerodynamic structure includes a pressure side, a suction side, and a trailing edge, the trailing edge having a modified aerodynamic contour.

9 Claims, 12 Drawing Sheets





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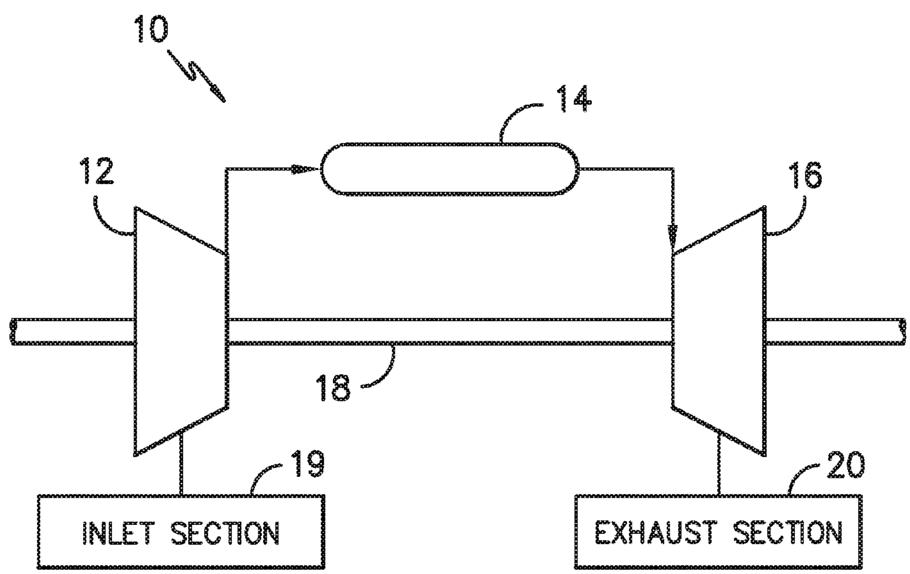
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INLET SECTION
EXHAUST SECTION

FIG. 1

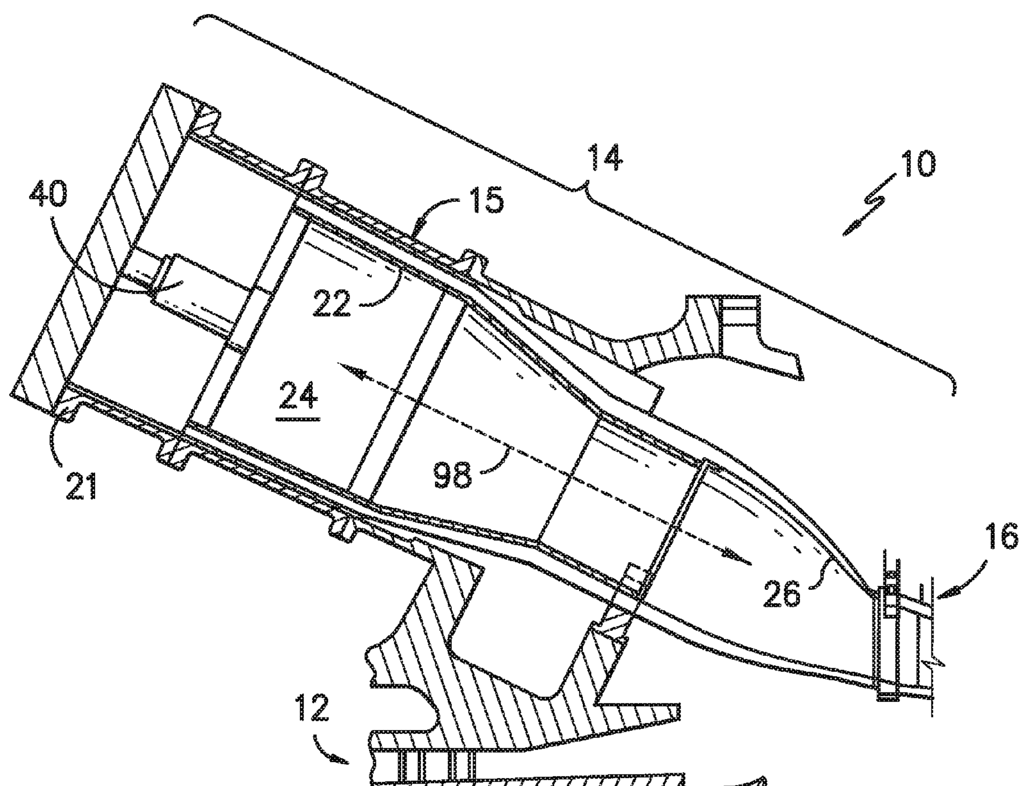
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FIG. 2

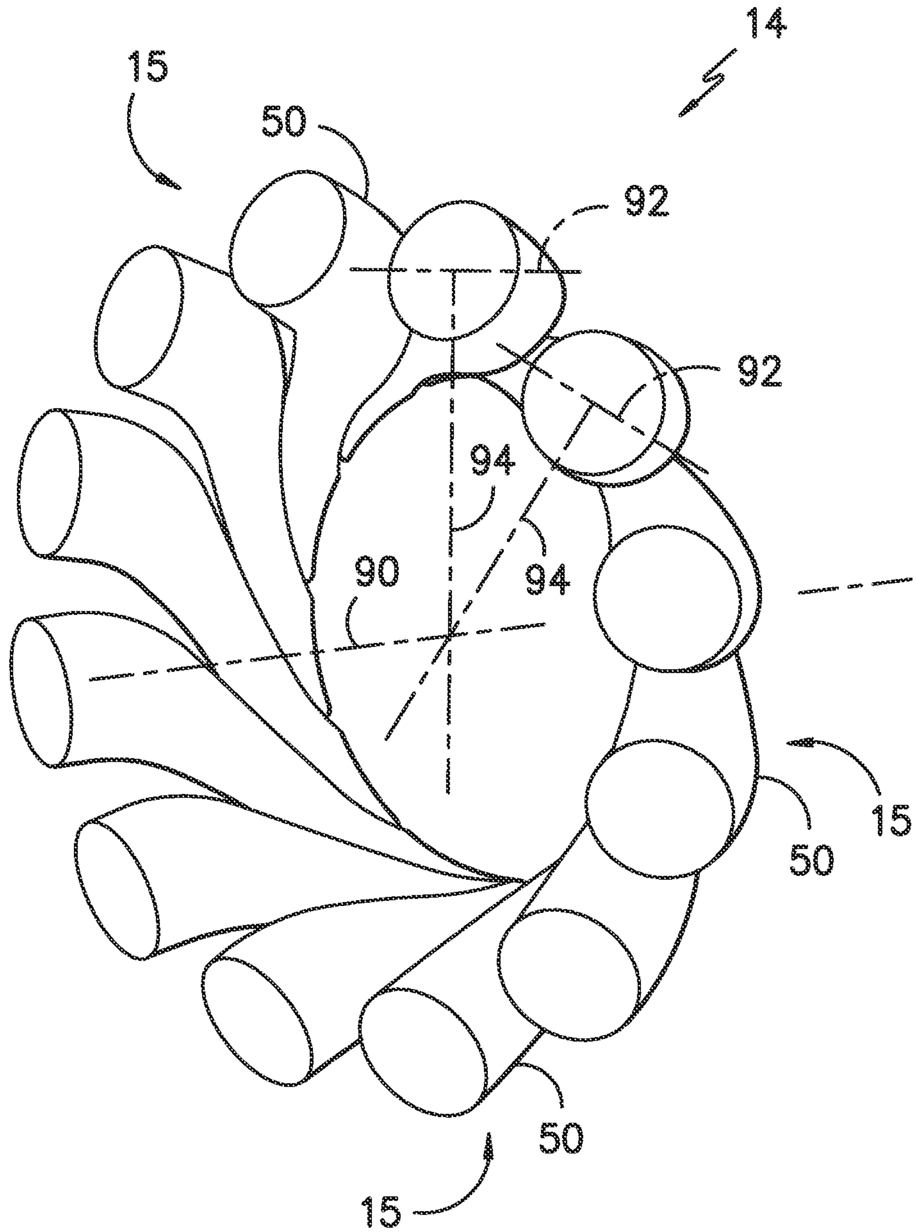

FIG. 3

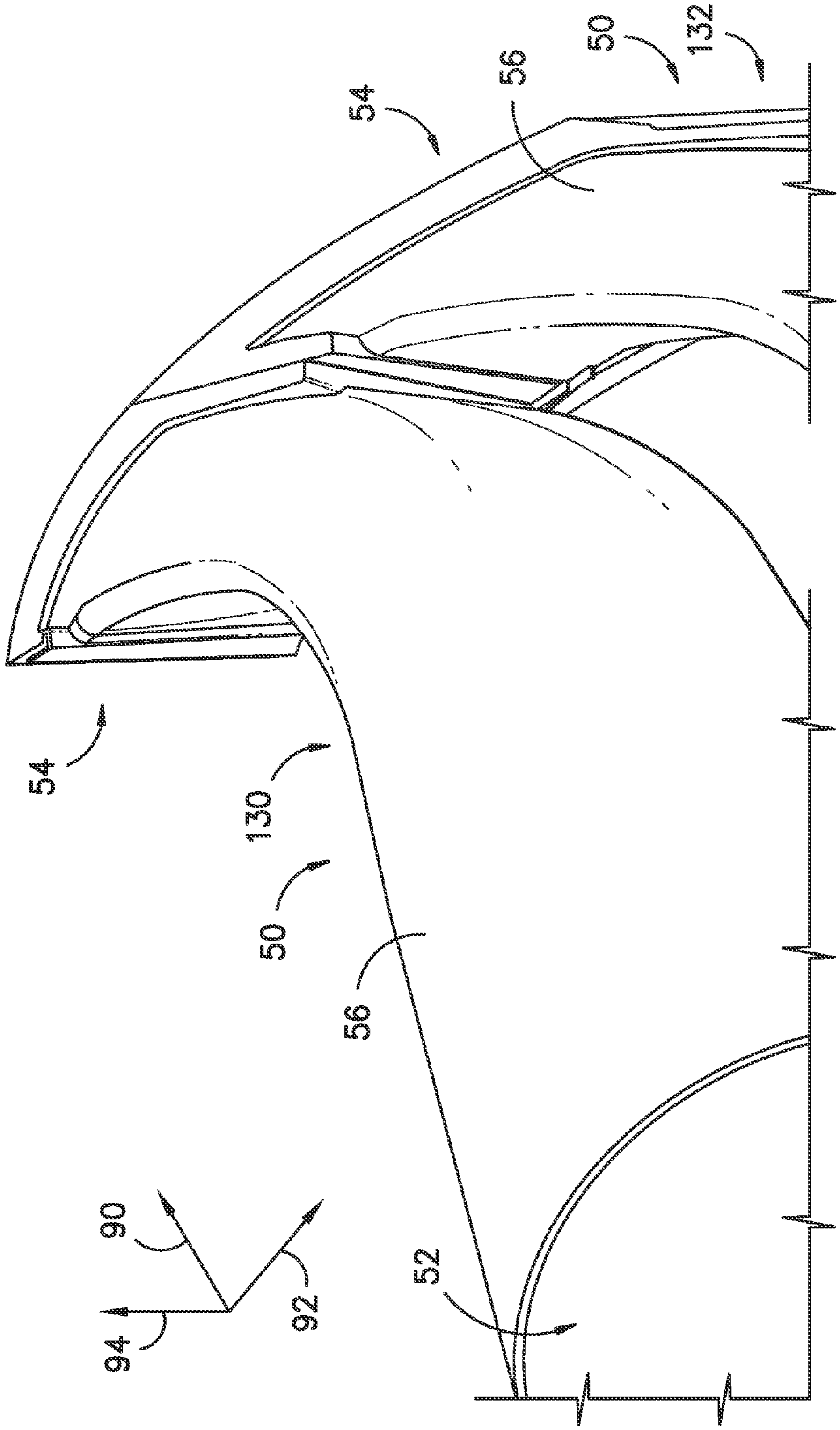

FIG. 4

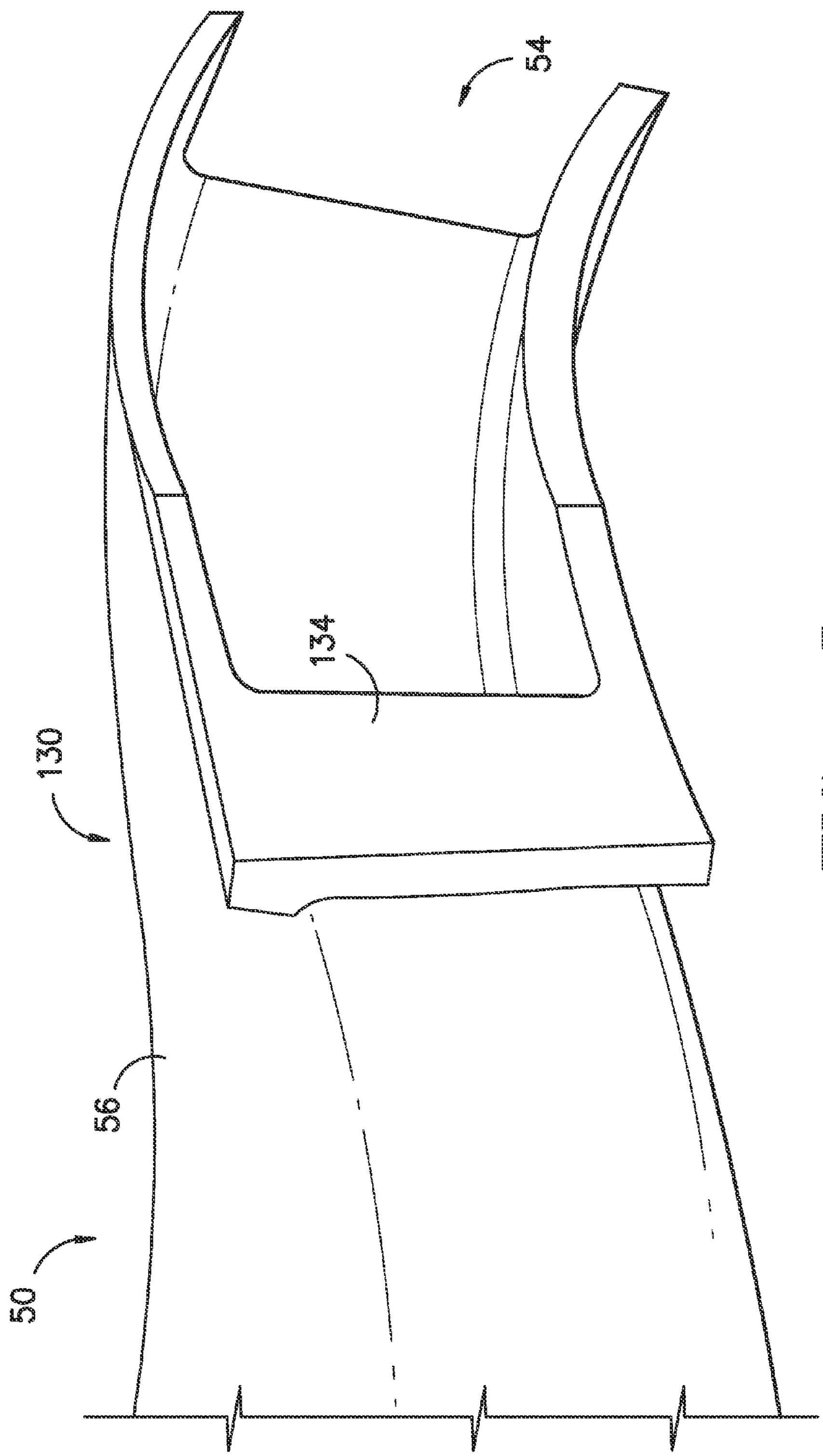

FIG. 5

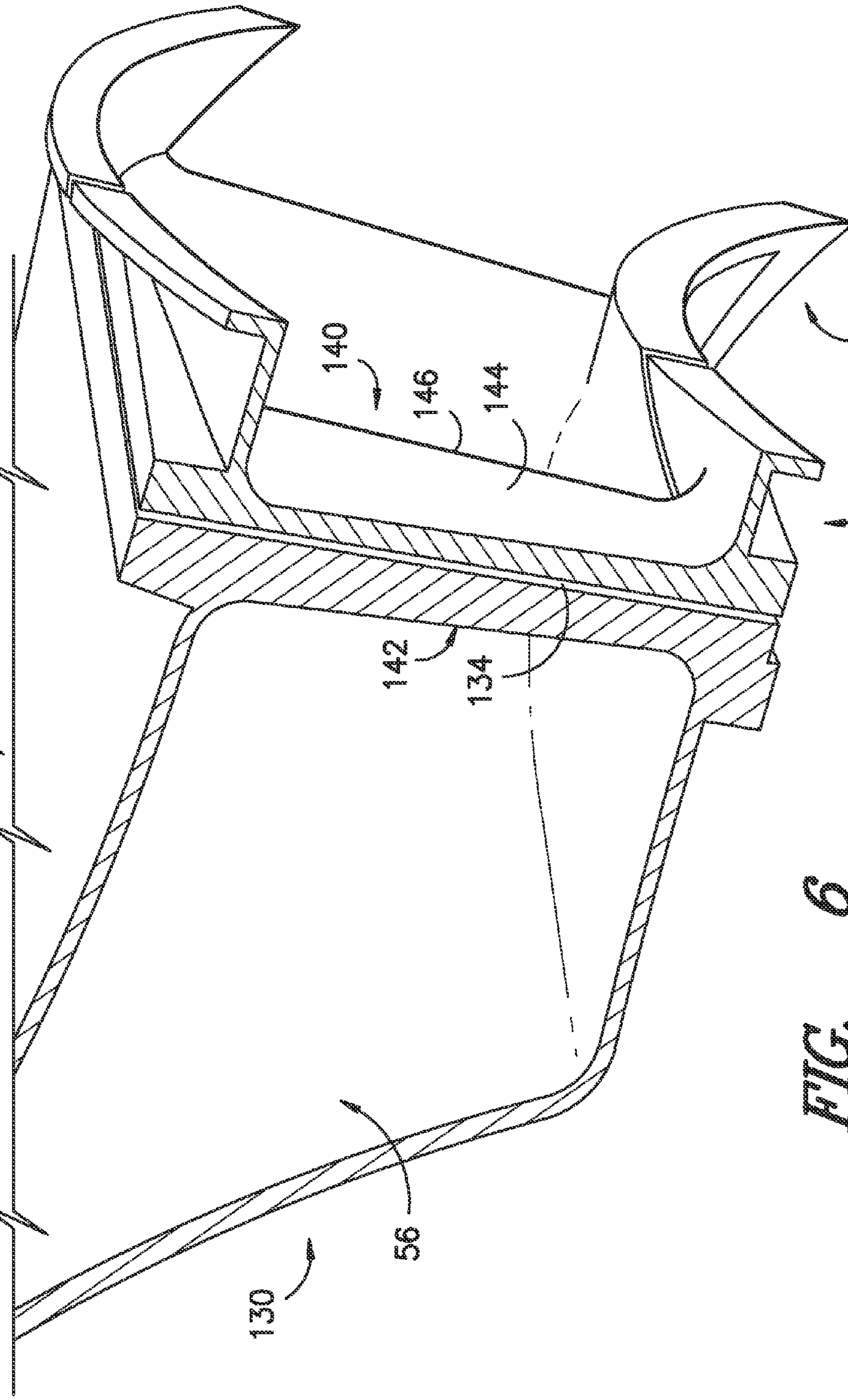

FIG. 6

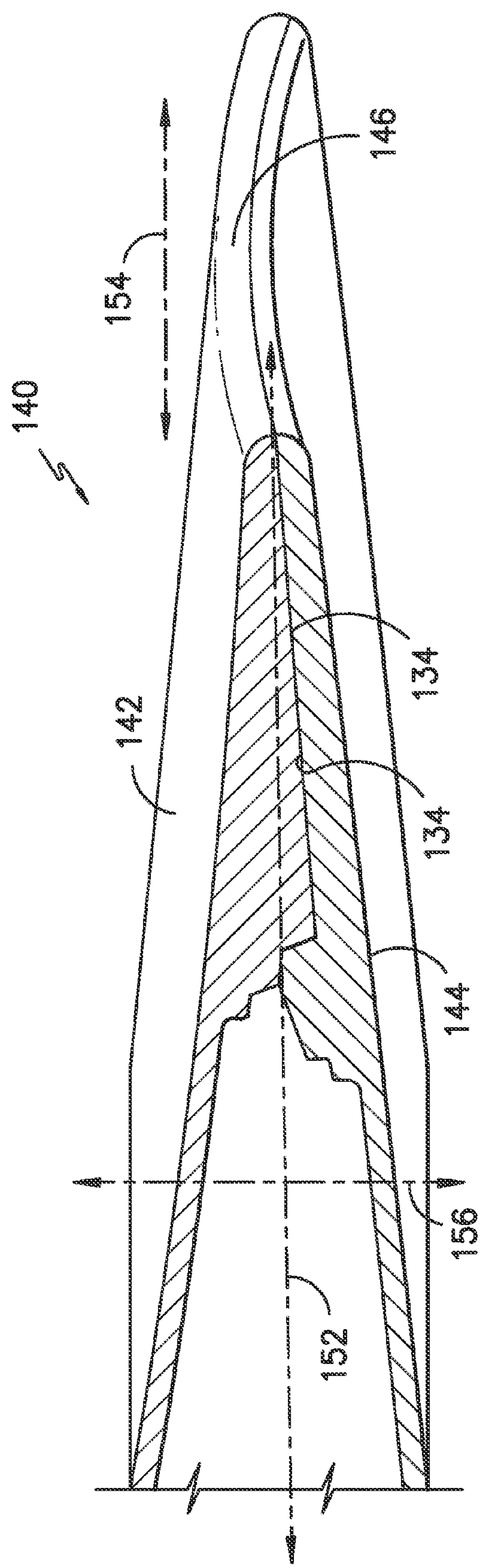

FIG. 7

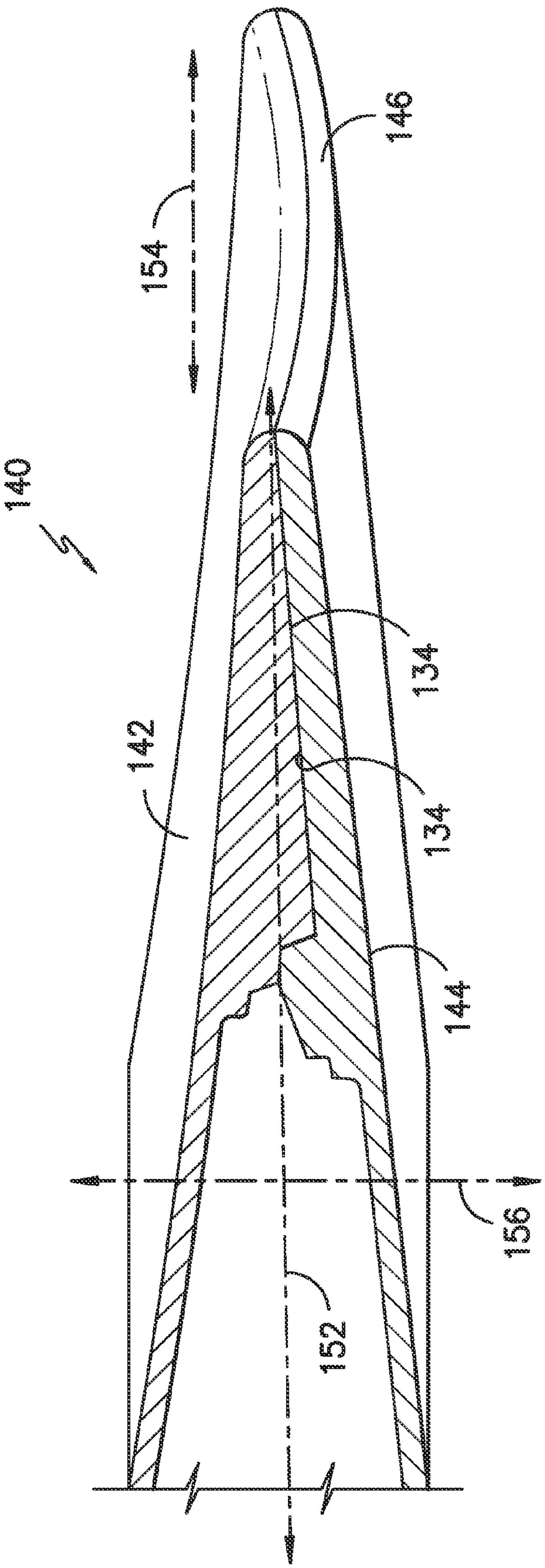

FIG. 8

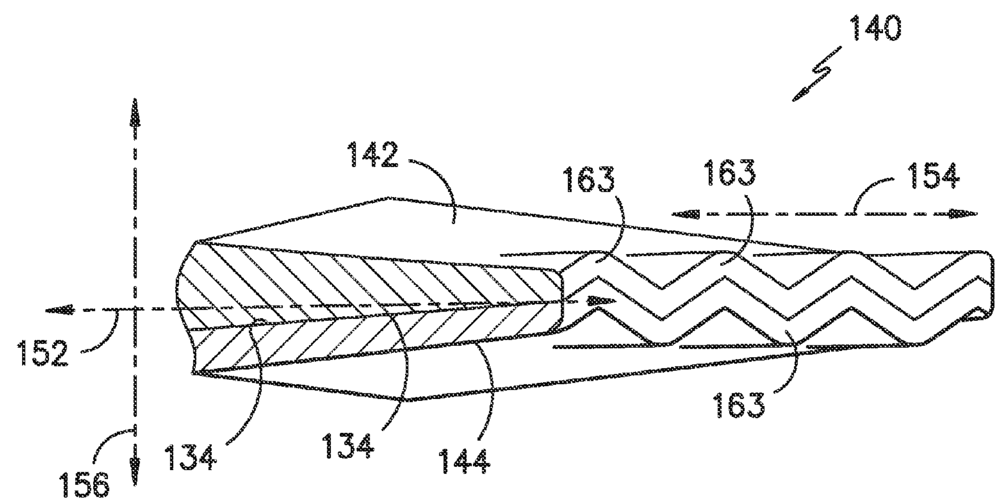
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FIG. 9

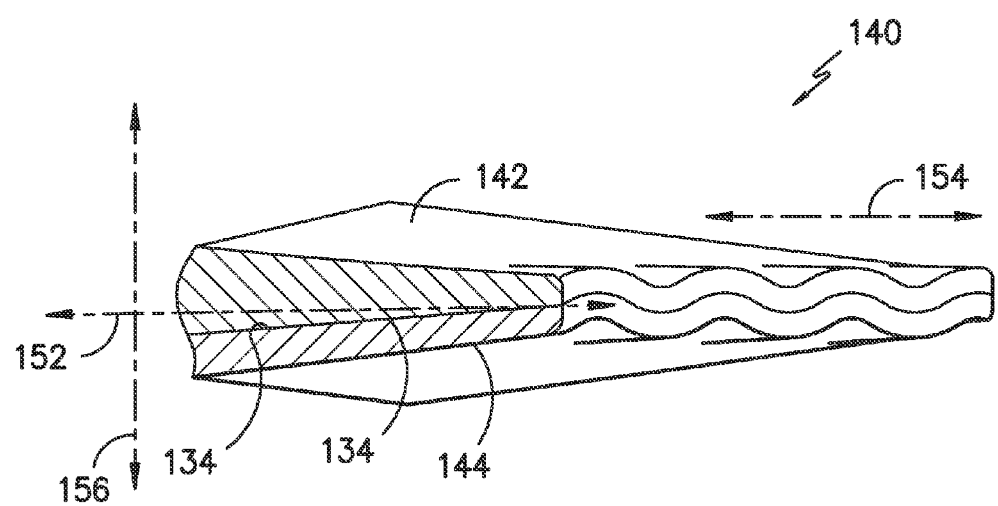
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FIG. 10

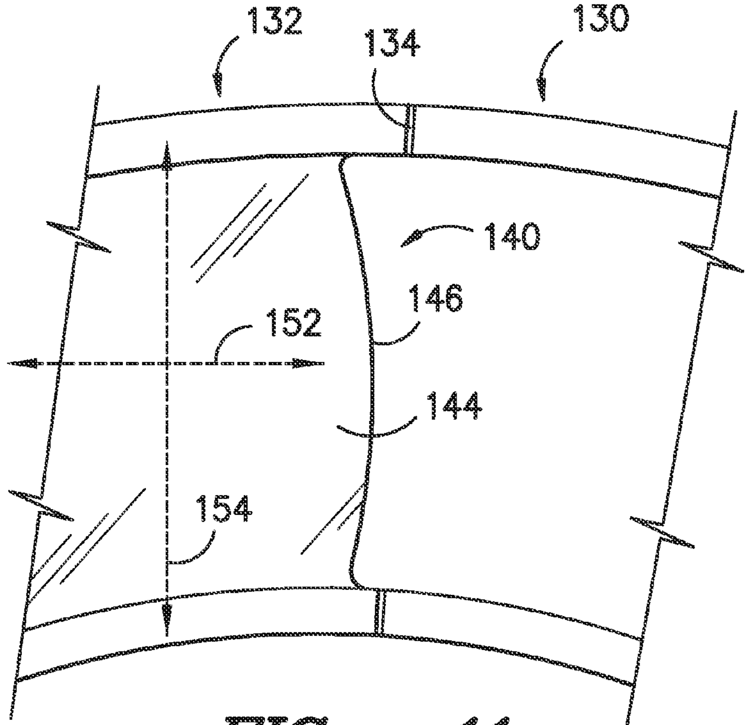

FIG. 11

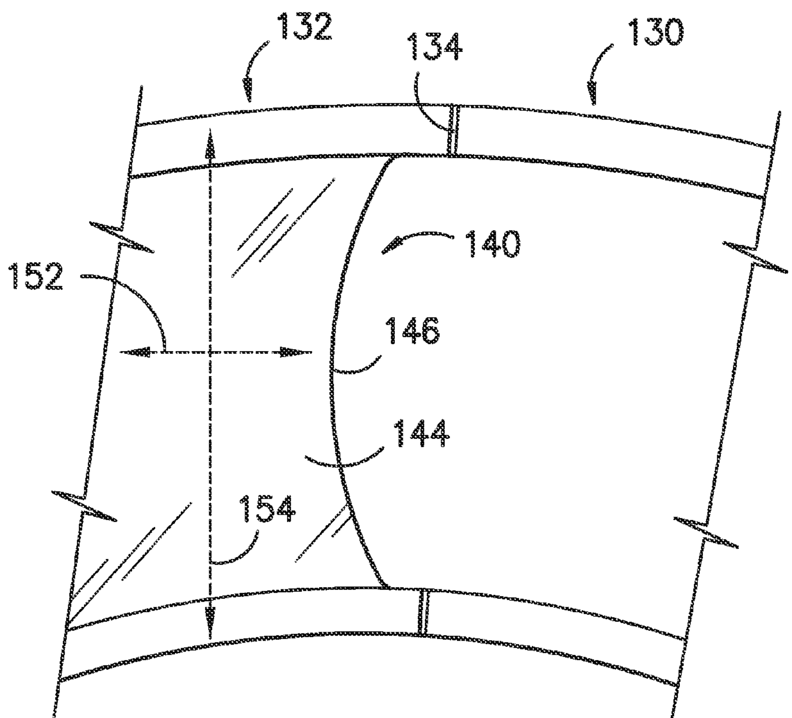

FIG. 12

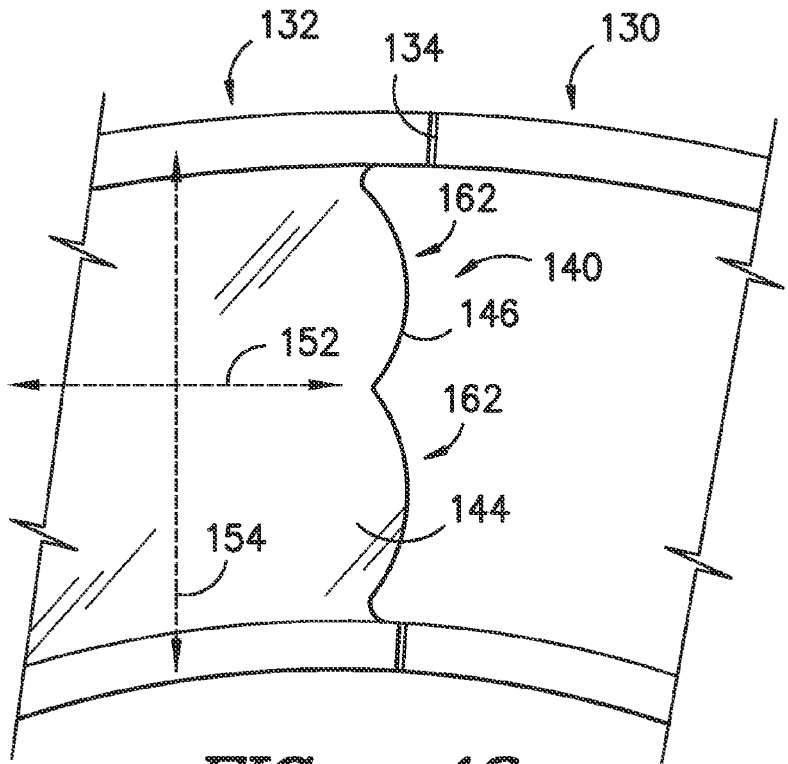
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FIG. 13

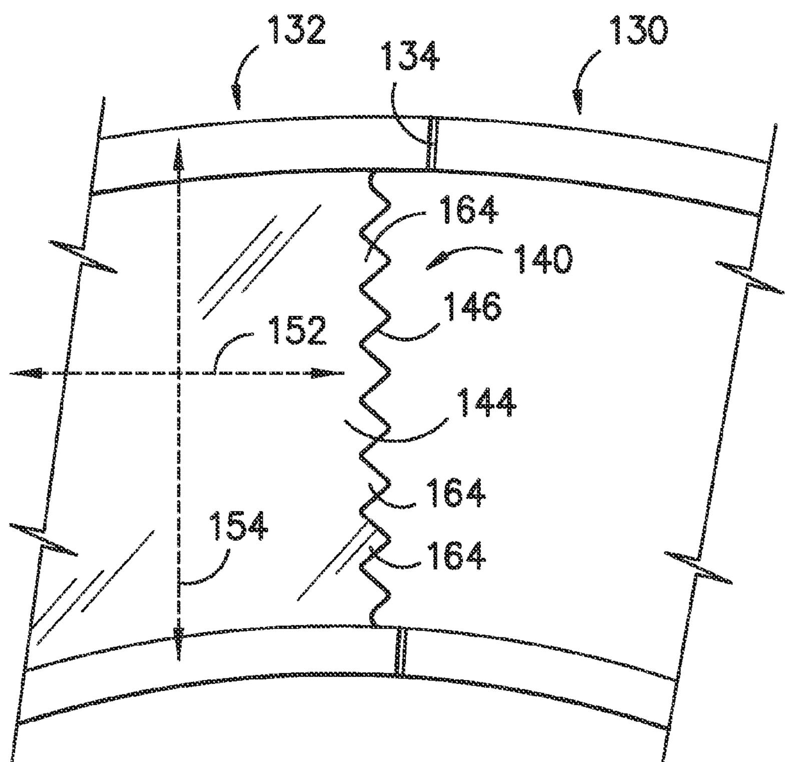
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FIG. 14

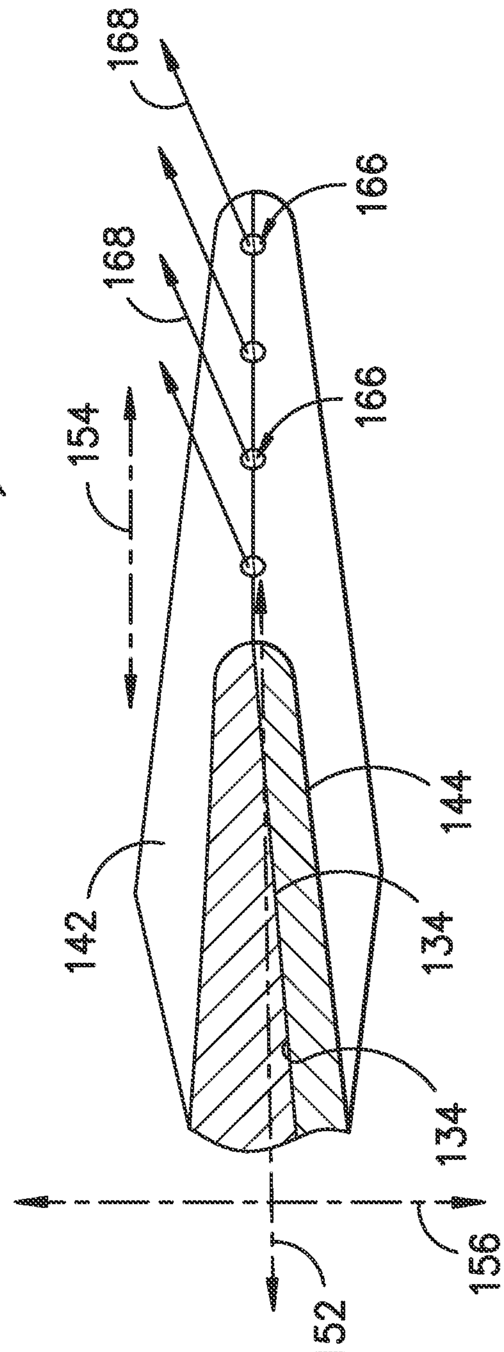

FIG. 15

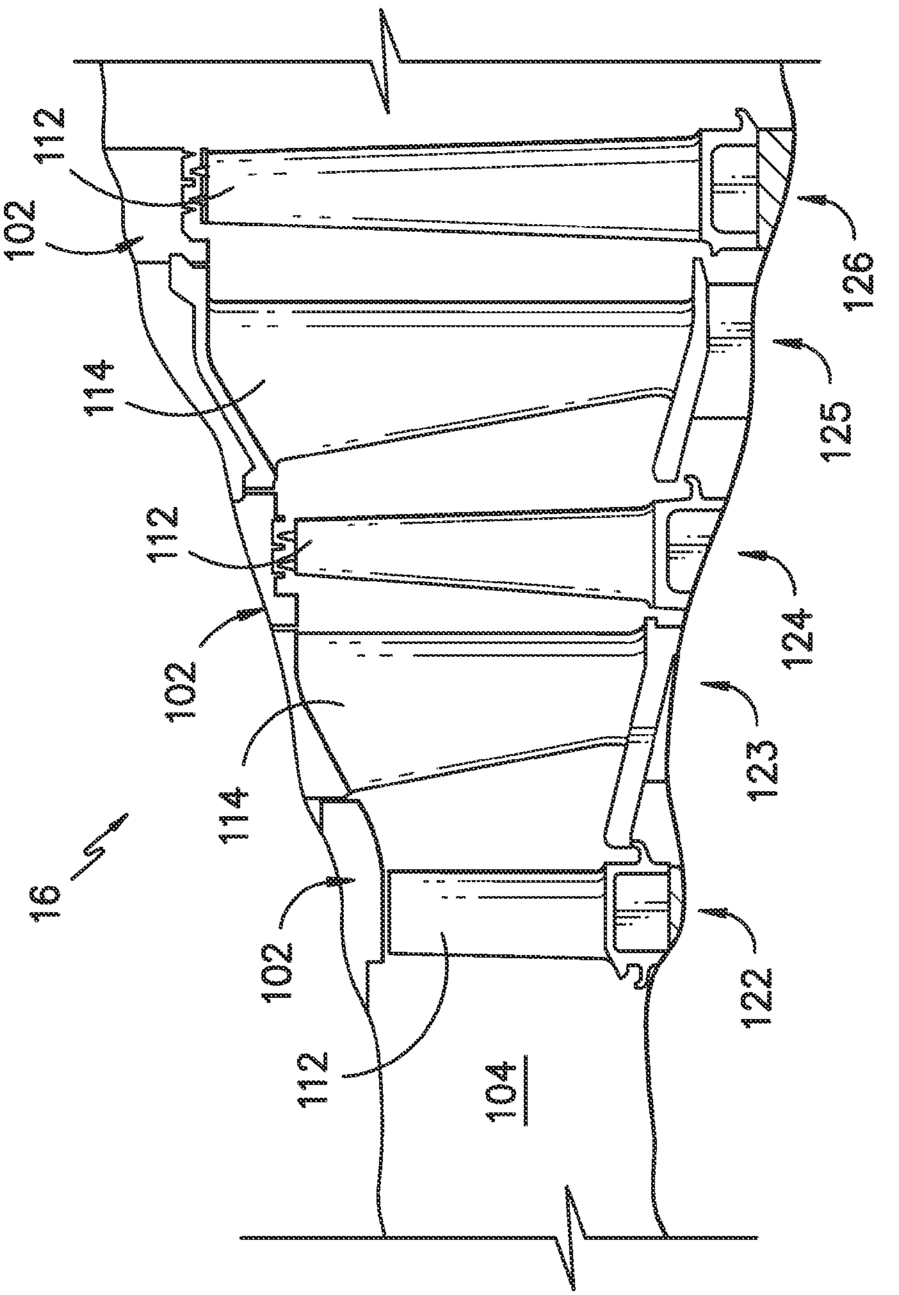

FIG. 16

TRANSITION DUCT ASSEMBLY WITH MODIFIED TRAILING EDGE IN TURBINE SYSTEM

This invention was made with government support under contract number DE-FC26-05NT42643 awarded by the Department of Energy. The government has certain rights in the invention.

FIELD OF THE INVENTION

The subject matter disclosed herein relates generally to turbine systems, and more particularly to transition ducts of turbine systems.

BACKGROUND OF THE INVENTION

Turbine systems are widely utilized in fields such as power generation. For example, a conventional gas turbine system includes a compressor section, a combustor section, and at least one turbine section. The compressor section is configured to compress air as the air flows through the compressor section. The air is then flowed from the compressor section to the combustor section, where it is mixed with fuel and combusted, generating a hot gas flow. The hot gas flow is provided to the turbine section, which utilizes the hot gas flow by extracting energy from it to power the compressor, an electrical generator, and other various loads.

The combustor sections of turbine systems generally include tubes or ducts for flowing the combusted hot gas therethrough to the turbine section or sections. Recently, combustor sections have been introduced which include tubes or ducts that shift the flow of the hot gas. For example, ducts for combustor sections have been introduced that, while flowing the hot gas longitudinally therethrough, additionally shift the flow radially or tangentially such that the flow has various angular components. These designs have various advantages, including eliminating first stage nozzles from the turbine sections. The first stage nozzles were previously provided to shift the hot gas flow, and may not be required due to the design of these ducts. The elimination of first stage nozzles may eliminate associated pressure drops and increase the efficiency and power output of the turbine system.

However, the aerodynamic efficiency of currently known transition ducts is of increased concern. For example, recent studies have shown that hot gas flows through such transition ducts have relatively high aerodynamic losses, in particular relatively high pressure losses. Further, such studies have indicated the production of relatively high wakes in the downstream portions of the transition ducts, resulting in non-uniform flow and high unsteady mixing losses downstream thereof. Due to such non-uniform flow and unsteady mixing, first stage buckets in the turbine sections may be subjected to high cycle fatigue loads and thermal loads, which may significantly reduce the durability of the buckets.

Accordingly, an improved transition duct for use in a turbine system would be desired in the art. For example, a transition duct that provides increased efficiency values would be advantageous. Further, a transition duct which minimizes mixing losses, thus reducing overall pressure losses and increasing system performance and efficiency, would be advantageous. Still further, a transition duct which reduces high cycle fatigue loads and thermal loads on turbine section first stage buckets would be advantageous.

BRIEF DESCRIPTION OF THE INVENTION

Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

In one embodiment, the present disclosure is directed to a transition duct assembly for a turbine system. The transition duct assembly includes a plurality of transition ducts disposed in a generally annular array and comprising a first transition duct and a second transition duct. Each of the plurality of transition ducts includes an inlet, an outlet, and a passage extending between the inlet and the outlet and defining a longitudinal axis, a radial axis, and a tangential axis. The outlet of each of the plurality of transition ducts is offset from the inlet along the longitudinal axis and the tangential axis. The transition duct assembly further includes an aerodynamic structure defined by the passages of the first transition duct and the second transition duct. The aerodynamic structure includes a pressure side, a suction side, and a trailing edge, the trailing edge having a modified aerodynamic contour.

These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

FIG. **1** is a schematic view of a gas turbine system according to one embodiment of the present disclosure;

FIG. **2** is a cross-sectional view of several portions of a gas turbine system according to one embodiment of the present disclosure;

FIG. **3** is a perspective view of an annular array of transition ducts according to one embodiment of the present disclosure;

FIG. **4** is a top perspective view of a plurality of transition ducts according to one embodiment of the present disclosure;

FIG. **5** is a side perspective view of a transition duct according to one embodiment of the present disclosure;

FIG. **6** is a cutaway perspective view of a transition duct assembly, comprising neighboring transition ducts and forming various portions of an airfoil therebetween according to one embodiment of the present disclosure;

FIG. **7** is a cross-sectional view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to one embodiment of the present disclosure;

FIG. **8** is a cross-sectional view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **9** is a cross-sectional view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **10** is a cross-sectional view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **11** is a side view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to one embodiment of the present disclosure;

FIG. **12** is a side view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **13** is a side view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **14** is a side view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure;

FIG. **15** is a cross-sectional view of portions of an airfoil, formed by a transition duct assembly comprising neighboring transition ducts, according to another embodiment of the present disclosure; and

FIG. **16** is a cross-sectional view of a turbine section of a gas turbine system according to one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

FIG. **1** is a schematic diagram of a turbomachine, which in the embodiment shown is a gas turbine system **10**. It should be understood that the turbomachine of the present disclosure need not be a gas turbine system **10**, but rather may be any suitable turbine system or other turbomachine, such as a steam turbine system or other suitable system. The system **10** as shown may include a compressor section **12**, a combustor section **14** which may include a plurality of combustors **15** as discussed below, and a turbine section **16**. The compressor section **12** and turbine section **16** may be coupled by a shaft **18**. The shaft **18** may be a single shaft or a plurality of shaft segments coupled together to form shaft **18**. The shaft **18** may further be coupled to a generator or other suitable energy storage device, or may be connected directly to, for example, an electrical grid. An inlet section **19** may provide an air flow to the compressor section **12**, and exhaust gases may be exhausted from the turbine section **16** through an exhaust section **20** and exhausted and/or utilized in the system **10** or other suitable system. Exhaust gases from the system **10** may for example be exhausted into the atmosphere, flowed to a steam turbine or other suitable system, or recycled through a heat recovery steam generator.

Referring to FIG. **2**, a simplified drawing of several portions of a gas turbine system **10** is illustrated. The gas turbine system **10** as shown in FIG. **2** comprises a compressor section **12** for pressurizing a working fluid, discussed below, that is flowing through the system **10**. Pressurized working fluid discharged from the compressor section **12** flows into a combustor section **14**, which may include a plurality of combustors **15** (only one of which is illustrated in FIG. **2**) disposed in an annular array about an axis of the system **10**. The working fluid entering the combustor section **14** is mixed with fuel, such as natural gas or another suitable liquid or gas, and combusted. Hot gases of combustion flow from each combustor **15** to a turbine section **16** to drive the system **10** and generate power.

A combustor **15** in the gas turbine **10** may include a variety of components for mixing and combusting the working fluid and fuel. For example, the combustor **15** may include a casing **21**, such as a compressor discharge casing **21**. A variety of sleeves, which may be axially extending annular sleeves, may be at least partially disposed in the casing **21**. The sleeves, as shown in FIG. **2**, extend axially along a generally longitudinal axis **98**, such that the inlet of a sleeve is axially aligned with the outlet. For example, a combustor liner **22** may generally define a combustion zone **24** therein. Combustion of the working fluid, fuel, and optional oxidizer may generally occur in the combustion zone **24**. The resulting hot gases of combustion may flow generally axially along the longitudinal axis **98** downstream through the combustion liner **22** into a transition piece **26**, and then flow generally axially along the longitudinal axis **98** through the transition piece **26** and into the turbine section **16**.

The combustor **15** may further include a fuel nozzle **40** or a plurality of fuel nozzles **40**. Fuel may be supplied to the fuel nozzles **40** by one or more manifolds (not shown). As discussed below, the fuel nozzle **40** or fuel nozzles **40** may supply the fuel and, optionally, working fluid to the combustion zone **24** for combustion.

Referring now to FIGS. **3** through **15**, a combustor **15** according to the present disclosure may include one or more transition ducts **50**, generally referred to as a transition duct assembly. The transition ducts **50** of the present disclosure may be provided in place of various axially extending sleeves of other combustors. For example, a transition duct **50** may replace the axially extending transition piece **26** and, optionally, the combustor liner **22** of a combustor **15**. Thus, the transition duct may extend from the fuel nozzles **40**, or from the combustor liner **22**. As discussed herein, the transition duct **50** may provide various advantages over the axially extending combustor liners **22** and transition pieces **26** for flowing working fluid therethrough and to the turbine section **16**.

As shown, the plurality of transition ducts **50** may be disposed in an annular array about a longitudinal axis **90**. Further, each transition duct **50** may extend between a fuel nozzle **40** or plurality of fuel nozzles **40** and the turbine section **16**. For example, each transition duct **50** may extend from the fuel nozzles **40** to the turbine section **16**. Thus, working fluid may flow generally from the fuel nozzles **40** through the transition duct **50** to the turbine section **16**. In some embodiments, the transition ducts **50** may advantageously allow for the elimination of the first stage nozzles in the turbine section, which may eliminate any associated drag and pressure drop and increase the efficiency and output of the system **10**.

Each transition duct **50** may have an inlet **52**, an outlet **54**, and a passage **56** therebetween. The inlet **52** and outlet **54** of a transition duct **50** may have generally circular or oval cross-sections, rectangular cross-sections, triangular cross-sections, or any other suitable polygonal cross-sections. Further, it should be understood that the inlet **52** and outlet **54** of a transition duct **50** need not have similarly shaped cross-sections. For example, in one embodiment, the inlet **52** may have a generally circular cross-section, while the outlet **54** may have a generally rectangular cross-section.

Further, the passage **56** may be generally tapered between the inlet **52** and the outlet **54**. For example, in an exemplary embodiment, at least a portion of the passage **56** may be generally conically shaped. Additionally or alternatively, however, the passage **56** or any portion thereof may have a generally rectangular cross-section, triangular cross-section, or any other suitable polygonal cross-section. It should be understood that the cross-sectional shape of the passage **56** may change throughout the passage **56** or any portion thereof as the passage **56** tapers from the relatively larger inlet **52** to the relatively smaller outlet **54**.

The outlet **54** of each of the plurality of transition ducts **50** may be offset from the inlet **52** of the respective transition duct **50**. The term "offset", as used herein, means spaced from along the identified coordinate direction. The outlet **54** of each of the plurality of transition ducts **50** may be longitudinally offset from the inlet **52** of the respective transition duct **50**, such as offset along the longitudinal axis **90**.

Additionally, in exemplary embodiments, the outlet **54** of each of the plurality of transition ducts **50** may be tangentially offset from the inlet **52** of the respective transition duct **50**, such as offset along a tangential axis **92**. Because the outlet **54** of each of the plurality of transition ducts **50** is tangentially offset from the inlet **52** of the respective transition duct **50**, the transition ducts **50** may advantageously utilize the tangential component of the flow of working fluid through the transition ducts **50** to eliminate the need for first stage nozzles in the turbine section **16**, as discussed below.

Further, in exemplary embodiments, the outlet **54** of each of the plurality of transition ducts **50** may be radially offset from the inlet **52** of the respective transition duct **50**, such as offset along a radial axis **94**. Because the outlet **54** of each of the plurality of transition ducts **50** is radially offset from the inlet **52** of the respective transition duct **50**, the transition ducts **50** may advantageously utilize the radial component of the flow of working fluid through the transition ducts **50** to further eliminate the need for first stage nozzles in the turbine section **16**, as discussed below.

It should be understood that the tangential axis **92** and the radial axis **94** are defined individually for each transition duct **50** with respect to the circumference defined by the annular array of transition ducts **50**, as shown in FIG. **3**, and that the axes **92** and **94** vary for each transition duct **50** about the circumference based on the number of transition ducts **50** disposed in an annular array about the longitudinal axis **90**.

As discussed, after hot gases of combustion are flowed through the transition duct **50**, they may be flowed from the transition duct **50** into the turbine section **16**. As shown in FIG. **16**, a turbine section **16** according to the present disclosure may include a shroud **102**, which may define a hot gas path **104**. The shroud **102** may be formed from a plurality of shroud blocks **106**. The shroud blocks **106** may be disposed in one or more annular arrays, each of which may define a portion of the hot gas path **104** therein.

The turbine section **16** may further include a plurality of buckets **112** and a plurality of nozzles **114**. Each of the plurality of buckets **112** and nozzles **114** may be at least partially disposed in the hot gas path **104**. Further, the plurality of buckets **112** and the plurality of nozzles **114** may be disposed in one or more annular arrays, each of which may define a portion of the hot gas path **104**.

The turbine section **16** may include a plurality of turbine stages. Each stage may include a plurality of buckets **112** disposed in an annular array and a plurality of nozzles **114** disposed in an annular array. For example, in one embodiment, the turbine section **16** may have three stages, as shown in FIG. **13**. For example, a first stage of the turbine section **16** may include a first stage nozzle assembly (not shown) and a first stage buckets assembly **122**. The nozzles assembly may include a plurality of nozzles **114** disposed and fixed circumferentially about the shaft **18**. The bucket assembly **122** may include a plurality of buckets **112** disposed circumferentially about the shaft **18** and coupled to the shaft **18**. In exemplary embodiments wherein the turbine section is coupled to combustor section **14** comprising a plurality of transition ducts **50**, however, the first stage nozzle assembly may be eliminated, such that no nozzles are disposed upstream of the first stage bucket assembly **122**. Upstream may be defined relative to the flow of hot gases of combustion through the hot gas path **104**.

A second stage of the turbine section **16** may include a second stage nozzle assembly **123** and a second stage buckets assembly **124**. The nozzles **114** included in the nozzle assembly **123** may be disposed and fixed circumferentially about the shaft **18**. The buckets **112** included in the bucket assembly **124** may be disposed circumferentially about the shaft **18** and coupled to the shaft **18**. The second stage nozzle assembly **123** is thus positioned between the first stage bucket assembly **122** and second stage bucket assembly **124** along the hot gas path **104**. A third stage of the turbine section **16** may include a third stage nozzle assembly **125** and a third stage bucket assembly **126**. The nozzles **114** included in the nozzle assembly **125** may be disposed and fixed circumferentially about the shaft **18**. The buckets **112** included in the bucket assembly **126** may be disposed circumferentially about the shaft **18** and coupled to the shaft **18**. The third stage nozzle assembly **125** is thus positioned between the second stage bucket assembly **124** and third stage bucket assembly **126** along the hot gas path **104**.

It should be understood that the turbine section **16** is not limited to three stages, but rather that any number of stages are within the scope and spirit of the present disclosure.

Each transition duct **50** may interface with one or more adjacent transition ducts **50**. For example, FIGS. **4** through **12** illustrate a first transition duct **130** and a second transition duct **132** of the plurality of transition ducts **50**. These neighboring transition ducts **130**, **132** may include contact faces **134**, which may be outer surfaces included in the outlets of the transition duct **50**. The contact faces **134** may contact associated contact faces **134** of adjacent neighboring transition ducts **50**, as shown, to provide an interface between the transition ducts **50**. For example, contact faces **134** of the first and second transition ducts **130**, **132** may, as shown, contact each other and provide an interface between the first and second transition ducts **130**, **132**.

Further, the adjacent transition ducts **50**, such as the first and second transition ducts **130**, **132**, may combine to form aerodynamic structures **140** therebetween having various aerodynamic surface of an airfoil. Such aerodynamic structure **140** may, for example, be defined by inner surfaces of the passages **56** of the transition ducts **50**, and further may be formed when the contact surfaces **134** of adjacent transition ducts **50** interface with each other. These various surfaces may shift the hot gas flow in the transition ducts **50**, and thus eliminate the need for first stage nozzles, as discussed above. For example, as shown in FIGS. **6** through **8**, an inner surface of a passage **56** of a transition duct **50**, such as a first transition duct **130**, may define a pressure side **142**, while an opposing inner surface of a passage **56** of an adjacent transition duct **50**, such as a second transition duct **132**, may define a suction side **144**. When the adjacent transition ducts **50**, such as the contact faces **134** thereof, interface with each other, the pressure side **142** and suction side **144** may combine to define a trailing edge **146**.

Referring now to FIGS. **7** through **15**, an aerodynamic structure **140** according to the present disclosure includes a trailing edge **146** that has a modified aerodynamic contour. The modified aerodynamic contour may, in exemplary embodiments, increase the efficiency of the transition ducts **50** and turbomachine in general by, for example, reducing aerodynamic losses and further reducing wakes during operation. Further, such modified aerodynamic contour may generate substantially uniform velocities and temperature fields impacting the stage one bucket assemblies. Thus, the stage one bucket assemblies advantageously experience reduced high cycle fatigue loads and thermal loads. Such flow conditions may thus improve the durability of the stage one bucket assemblies.

A trailing edge **146** may have a modified aerodynamic contour through modification of the shape of the trailing edge **146** and/or orientation of the trailing edge **146**. For example, FIGS. **7** through **10** illustrate various embodiments of trailing edges **146** having modified aerodynamic contours according to exemplary embodiments of the present disclosure. As shown, an aerodynamic structure **140** according to the present disclosure defines a chord-wise axis **152**, a span-wise axis **154**, and a yaw axis **156**. Each axis **152**, **154**, **156** is generally perpendicular to the other axes, as shown, such that for example, the yaw axis **156** is perpendicular to the chord-wise axis **152** and the span-wise axis **154**. FIGS. **7** and **8** illustrate views of an aerodynamic structure **140**, with a plane defined by the span-wise axis **154** and the yaw axis **156**. The trailing edge **146**, or at least a portion thereof, may be curvilinear or chevron-shaped in this plane, as shown. For example, in some embodiments the trailing edge **146** may be curved towards the pressure side **142**, as shown in FIG. **7**, while in other embodiments, the trailing edge **146** may be curved towards the suction side **144**, as shown in FIG. **8**. Further, while FIGS. **7** and **8** illustrate trailing edges **146** having single curvilinear sections, in other embodiments as illustrated in FIG. **10**, a trailing edge **146** may include a plurality of curvilinear sections. Each section may have an independent curve, which may be curved towards the pressure side **142** or suction side **144**. Two, three, four or more curvilinear sections may be provided. Thus, the trailing edge **146** may be have a curvilinear pattern which alternates curves towards the pressure side **142** and suction side **144**. Alternatively, referring to FIG. **9**, the trailing edge **146** may comprises a plurality of chevrons **163**, such that a sawtooth pattern is generally provided through the trailing edge **146** or a portion thereof in the plane defined by the span-wise axis **154** and yaw axis **156**. Alternatively, bristles or other suitably shaped features may be provided on the trailing edge **146** and extend in the plane to cause turbulent flow similar to the operation of the chevrons **163**.

FIGS. **11** through **13** illustrate various further embodiments of an aerodynamic structure **140** with a trailing edge **146** having a modified aerodynamic contour. For example, FIGS. **11** through **13** illustrate views of an aerodynamic structure **140** in a plane defined by the chord-wise axis **152** and the span-wise axis **154**. The trailing edge **146**, or at least a portion thereof, may be curvilinear in this plane, as shown. For example, in some embodiments as shown in FIG. **12**, the trailing edge **146** may have a convex curvilinear shape. In other embodiments, as shown in FIG. **11**, the trailing edge **146** may have a concave curvilinear shape. Further, while FIGS. **11** and **12** illustrate trailing edges **146** having single curvilinear sections, in other embodiments as shown in FIG. **13**, a trailing edge **146** may include a plurality of curvilinear sections **162**. Each section **162** may have an independent curve, which may be convex as shown or concave. Two, three, four or more curvilinear sections **162** may be provided.

FIG. **14** illustrates a further embodiment of an aerodynamic structure **140** with a trailing edge **146** having a modified aerodynamic contour in the plane defined by the chord-wise axis **152** and the span-wise axis **154**. In these embodiments, the trailing edge **146** comprises a plurality of chevrons **164**, such that a sawtooth pattern is generally provided through the trailing edge **146** or a portion thereof in the plane defined by the chord-wise axis **152** and the span-wise axis **154**. Alternatively, bristles or other suitably shaped features may be provided on the trailing edge **146** and extend in the plane to cause turbulent flow similar to the operation of the chevrons **164**.

FIG. **15** illustrates a further embodiment of an aerodynamic structure **140** with a trailing edge **146** having a modified aerodynamic contour. In these embodiments, one or more channels **166** may be defined in the trailing edge **146**, such as between portions of the contact faces **134**. Jets of suitable gases **168**, such as portions of the combustion gases, cooling gases, etc., may be flowed through channels **166** and exhausted at the trailing edge **146**. Thus, fluidics mixing may be facilitated by the channels **166** and the exhaust gases **168** therefrom. The channels **166** may positioned such that gases **168** are exhausted generally along the chord-wise axis **152**, or at a suitable angle, such as an angle to the chord-wise axis **152** in the plane defined by the chord-wise axis **152** and the yaw axis **156** and/or the plane defined by the chord-wise axis **152** and the span-wise axis **154**.

Accordingly, transition duct assemblies comprising a plurality of transition ducts **50** defining aerodynamic structures **140** therebetween according to the present disclosure beneficially experience increased efficiency during turbomachine operation. For example, the use of aerodynamic structures **140** which include trailing edges **146** that have modified aerodynamic contours as discussed herein may increase the efficiency of the transition ducts **50** and turbomachine in general by, for example, reducing aerodynamic losses and further reducing wakes during operation.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A transition duct assembly for a turbine system, the transition duct assembly comprising:

a plurality of transition ducts disposed in a generally annular array and comprising a first transition duct and a second transition duct, each of the plurality of transition ducts comprising a radially inner wall portion, a radially outer wall portion, a radially extending side wall portion coupled to and extending between the radially inner wall portion and the radially outer wall portion, an inlet, an outlet, and a passage extending between the inlet and the outlet and defining a longitudinal axis, a radial axis, and a tangential axis, the outlet of each of the plurality of transition ducts offset from the corresponding inlet of each of the plurality of transition ducts along the corresponding longitudinal and tangential axes of each of the plurality of transition ducts, wherein each of the plurality of transition ducts directs combustion gases at least partially along the corresponding tangential axis of each of the plurality of transition ducts; and

an aerodynamic structure partially formed by adjacent radially extending side wall portions of the first transition duct and the second transition duct, the aerodynamic structure comprising a pressure side, a suction side, and a trailing edge and defining a chord-wise axis extending from an inlet side of the aerodynamic structure to an outlet side of the aerodynamic structure, a span-wise axis perpendicular to the chord-wise axis and extending between the radially inner wall portions of the first and second transition ducts and the radially outer wall portions of the first and second transition ducts, and a yaw axis perpendicular to the chord-wise axis and the span-wise axis and extending between the pressure side and the suction side, wherein the trailing edge comprises a lobe extending from the radially inner wall portions of the first and second transition ducts to the radially outer wall portions of the first and second transition ducts, the lobe being entirely curvilinear in a plane defined by the chord-wise axis and the span-wise axis.

2. The transition duct assembly of claim **1**, wherein the lobe is convex.

3. The transition duct assembly of claim **1**, wherein the lobe is concave.

4. The transition duct assembly of claim **1**, wherein the outlet of each of the plurality of transition ducts is further offset from the inlet of each of the plurality of transition ducts along the corresponding radial axis of each of the plurality of transition ducts.

5. A turbomachine, comprising:

an inlet section;

an exhaust section;

a compressor section;

a turbine section; and

a combustor section between the compressor section and the turbine section, the combustor section comprising:

a plurality of transition ducts disposed in a generally annular array and comprising a first transition duct and a second transition duct, each of the plurality of transition ducts comprising a radially inner wall portion, a radially outer wall portion, a radially extending side wall portion coupled to and extending between the radially inner wall portion and the radially outer wall portion, an inlet, an outlet, and a passage extending between the inlet and the outlet and defining a longitudinal axis, a radial axis, and a tangential axis, the outlet of each of the plurality of transition ducts offset from the corresponding inlet of each of the plurality of transition ducts along the corresponding longitudinal and tangential axes of each of the plurality of transition ducts, wherein each of the plurality of transition ducts directs combustion gases at least partially along the corresponding tangential axis of each of the plurality of transition ducts; and

an aerodynamic structure partially formed by adjacent radially extending side wall portions of the first transition duct and the second transition duct, the aerodynamic structure comprising a pressure side, a suction side, and a trailing edge and defining a chord-wise axis extending from an inlet side of the aerodynamic structure to an outlet side of the aerodynamic structure, a span-wise axis perpendicular to the chord-wise axis and extending between the radially inner wall portions of the first and second transition ducts and the radially outer wall portions of the first and second transition ducts, and a yaw axis perpendicular to the chord-wise axis and the span-wise axis and extending between the pressure side and the suction side, wherein the trailing edge comprises a lobe extending from the radially inner wall portions of the first and second transition ducts to the radially outer wall portions of the first and second transition ducts, the lobe being entirely curvilinear in a plane defined by the chord-wise axis and the span-wise axis.

6. The turbomachine of claim **5**, wherein the turbine section comprises a first stage bucket assembly, and wherein no first stage nozzles are disposed upstream of the first stage bucket assembly in the turbine section.

7. The turbomachine of claim **5**, wherein the lobe is convex.

8. The turbomachine of claim **5**, wherein the lobe is concave.

9. The turbomachine of claim **5**, wherein the outlet of each of the plurality of transition ducts is further offset from the inlet of each of the plurality of transition ducts along the corresponding radial axis of each of the plurality of transition ducts.

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